

ASPECTS OF ANIMAL WELFARE AND AQUACULTURE

A Compendium of Selected Literature

The welfare status of captive livestock is an important determinant of society's overall acceptance of farming technology, and of agrifood production systems in general. Unlike other forms of livestock agriculture however, there is a paucity of scientific, objective information concerning various aspects of the biology, behaviour, neurophysiology and welfare status of captive fish. This extensive bibliography consolidates a wide variety of scientific literature and other reference materials in an effort to provide an information platform to encourage a better understanding of fish welfare as it relates to the aquaculture industry.

Prepared By:

Richard D. Moccia
Associate Professor, Aquaculture
University of Guelph

&

Kristopher P. Chandroo
M.Sc. (Animal Science)
University of Guelph

January 15, 2001
(updated Nov 29,2010)

- An Annotated Bibliography -

Animal Welfare – General Topics

Anonymous. 1979. The welfare of the food animals: An assessment of developments in the livestock industry and recommendations for the most practical way in which animal welfare requirements can be met. Proceedings of a Symposium, The Universities Federation for Animal Welfare, September 28-29, 1978, p. 68.

Battye, J. 1994. Ethics and Animal Welfare - Where do we go from here? In: Animal Welfare in the 21st Century: Ethical, Educational and Scientific Challenges (Eds. R.M. Baker, D.J. Mellor and A.M. Nicol, p. 3-10.

Brambell F. W. R. 1965. Report of the technical committee to enquire into the welfare of animals kept under intensive husbandry systems. Command Report 2836, Her Majesty's Stationery Office, London.

Broom D. M. 1993. A usable definition of animal welfare. Journal of Agricultural and Environmental Ethics (Supplement 2) 6, 15-25.

Broom D. M. & Johnson K. G. 1993. *Stress and Animal Welfare* (ed. by D.M. Broom). Chapman & Hall, London.

Bower, J. 1990. Farm animal welfare in the 1990s. Some hopes and hindrances. Oxford, England, Education Services, p. 16.

Curtis S. E. 1985. What constitutes animal well-being? In: *Animal Stress* (ed. by G.P. Moberg), pp. 1-13. American Physiological Society, Bethesda, Maryland.

Curtis S. E. & Stricklin W. R. 1991. The importance of animal cognition in agricultural animal production systems: an overview. Journal of Animal Science 69, 5001-5007.

Dantzer, R., P. Mormede and J.P. Henry. 1983. Physiological assessment of adaptation in farm animals. In: Farm Animal Housing and Welfare. S.H. Baxter, M.R. Baxter and J.A.C MacCormack (Eds.). Martinus Nijhoff Publishers, p. 8-19.

Dantzer R. 1993. Research perspectives in farm animal welfare: the concept of stress. Journal of Agricultural and Environmental Ethics (Supplement 2) 6, 86-92.

Dawkins, M.S. 1980. Animal Suffering: the Science of Animal Welfare. Chapman and Hall, London.

Dawkins, M.S. 1995. Unravelling Animal Behaviour. 2nd, Edition, Longman, London.

Degrazia D. 1999. Animal ethics around the turn of the twenty-first century. Journal of Agricultural and Environmental Ethics 11, 111-129.

- Duncan, I.J.H. 1990. Animal welfare what is it and how can we measure it? In: Farm and Animal Welfare in the 1990's: A symposium sponsored by Alberta Institute of Agrologists, Edmonton Branch, p. 15.
- Duncan I. J. H. 1993. Welfare is to do with what animals feel. *Journal of Agricultural and Environmental Ethics* (Supplement 2) 6, 8-14.
- Duncan I. J. H. 1996. Animal Welfare Defined in Terms of Feelings. *Acta Agriculturae Scandinavica, Section A, Animal Science*, Supplementum 27, 29-35.
- Duncan I. J. H. & Fraser D. 1997. Understanding animal welfare. In: *Animal Welfare* (ed. by M.C. Appleby & B.O. Hughes), pp. 19-31. CAB International. University Press, Cambridge.
- Duncan I. J. H. & Petherick J. C. 1991. The implications of cognitive processes for animal welfare. *Journal of Animal Science* 69, 5017-5022.
- Ewbank R. 1993. Animal welfare: a historical overview. *Journal of Agricultural and Environmental Ethics* (Supplement 1) 6, 82-86.
- Flecknell P. A. & Molony V. 1997. Pain and Injury. In: *Animal Welfare* (ed. by M.C. Appleby & B.O. Hughes), pp. 63-73, CAB International. University Press, Cambridge.
- Fraser, D. 1993. Assessing animal well-being: Common sense, uncommon science. In: Food Animal Well-Being 1993 Conference Proceedings and Deliberations. p. 37-54. Purdue, Univ., West Lafayette, IN.
- Fraser, D. and M.L. Leonard. 1993. Farm animal welfare. In: Martin, J., Hudson, R.J. and Young, B.A. (eds). *Animal production in Canada*. University of Alberta, Edmonton, p. 340.
- Fraser D. & Duncan I. J. H. 1998. 'Pleasures', 'Pains' and animal welfare: toward a natural history of affect. *Animal Welfare* 7, 383-396.
- Fraser D. & Matthews L. R. 1997. Preference and motivation testing. In: *Animal Welfare* (ed. by M.C. Appleby & B.O. Hughes), pp. 159-173. CAB International. University Press, Cambridge.
- Fraser D., Weary D. M., Pajor E. A. & Milligan B. N. 1997. A scientific conception of animal welfare that reflects ethical concerns. *Animal Welfare* 6, 187-205.
- Gonyou H. W. 1993. Animal welfare: definitions and assessment. *Journal of Agricultural and Environmental Ethics* (Supplement 2) 6, 37-43.
- Hill, J.R. and W.B. Sainsbury. 1990. Farm animal welfare: Who cares? How? The Cambridge Centre for Animal Health and Welfare, Cambridge, UK.
- Humphrey N. K. 1981. Having Feelings, and Showing Feelings. In: *Self-Awareness in Domesticated Animals* (ed. by D.G.M. Wood-Gush, M. Dawkins & R. Ewbank), pp. 37-39. Universities Federation for Animal Welfare. Potters Bar, England.

- Hurnik J. F. 1993. Ethics and Animal Agriculture. *Journal of Agricultural and Environmental Ethics* (Supplement 1) 6, 21-35.
- Hurnik J. F. & Lehman H. 1988. Ethics and farm animal welfare. *Journal of Agricultural Ethics* 1, 305-318.
- Jensen K. K. & Sørensen J. T. 1999. The idea of "ethical accounting" for a livestock farm. *Journal of Agricultural and Environmental Ethics* 11, 85-100.
- Manteca X. 1998. Neurophysiology and assessment of welfare. *Meat Science* (Supplement 1) 49, S205-S218.
- McGlone J. J. 1993. What is animal welfare? *Journal of Agricultural and Environmental Ethics* (Supplement 2) 6, 26-36.
- Mench J. A. 1993. Assessing animal welfare: an overview. *Journal of Agricultural and Environmental Ethics* (Supplement 2) 6, 68-75.
- Mench J. A. & Madson G. J. 1997. Behaviour. In: *Animal Welfare* (ed. by M.C. Appleby & B.O. Hughes), pp. 127-141. CAB International. University Press, Cambridge.
- Mendl M. 1991. Some problems with the concept of a cut-off point for determining when an animal's welfare is at risk. *Applied Animal Behaviour Science* 31, 139-146.
- Moberg G. P. 1985. Biological response to stress: key to assessment of animal well-being? In: *Animal Stress* (ed. G.P. Moberg), pp. 27-49. American Physiological Society, Bethesda, Maryland.
- Moberg G. P. 1993. Using risk assessment to define domestic animal welfare. *Journal of Agricultural and Environmental Ethics* (Supplement 2) 6, 1-7.
- Newman, S. 1994. Quantitative and molecular genetic effects on animal well-being: adaptive mechanisms. *J. Anim. Sci.* 72: 1641-1653.
- Price E. O. 1985. Evolutionary and ontogenetic determinants of animal suffering and well-being. In: *Animal Stress* (ed. G.P. Moberg), pp. 15-25. American Physiological Society, Bethesda, Maryland.
- Rodd, R. 1990. *Biology, Ethics, and Animals*. Clarendon Press, New York, p. 272.
- Rollin B. E. 1993. Animal welfare, science, and value. *Journal of Agricultural and Environmental Ethics* (Supplement 2) 6, 44-50.
- Rollin, B.E. 1996. Bad ethics, good ethics and the genetic engineering of animals in agriculture. *J. Anim. Sci.* 74: 535-54.
- Sandoe, P. and H.B. Simonsen. 1992. Assessing animal welfare: where does science end and philosophy begin? *Animal Welfare* 1: 257-267.
- Singer, P. 1975. *Animal Liberation - A new ethics for our treatment of animals*. Random House Publishers, New York, p. 301.

Spedding C. R. W. 1993. Animal welfare policy in Europe. *Journal of Agricultural and Environmental Ethics* (Supplement 1) 6, 110-117.

Sumner, L.W. 1988. Animal welfare and animal rights. *J. Med. Philosophy* 13: 159-175.

Webster, J. 1984. Problems of confinement on farms / in laboratories and in the home. In: *Priorities in Animal Welfare*. The British Veterinary Association Animal Welfare Foundation, p. 55-61.

Webster J. 1995. *Animal Welfare: a cool eye towards eden*. Blackwell Science Ltd., London .

Wunderlich, G. 1991. The ethics of animal agriculture. *Food Review* 14: 24-27.

Fish Welfare

Anon. 1997. A report on the animal welfare aspects of fish farming. Animal Welfare Foundation of Canada.

Bernoth E. M. 1991. Intensive culture of freshwater fish. *Deutsche Tierärztliche Wochenschrift* 98, 312-316.

Bernoth E. M. & Wormuth H. J. 1990. Animal protection aspects on killing fish. *Deutsche Tierärztliche Wochenschrift* 97, 154-157.

Casebolt D. B., Speare D. J. & Horney B. S. 1998. Care and use of fish as laboratory animals: current state of knowledge. *Laboratory Animal Science* 48, 124-136.

Chandroo K. P. 1999. Animal welfare and Aquaculture. *Ontario Aquaculture Association Newsletter* March-April, 3.

Chandroo K. P. 2000. Assessing the welfare status of farmed rainbow trout (*Oncorhynchus mykiss*) with electromyogram telemetry. Master's Thesis, University of Guelph.

Chandroo K. P., Moccia R. D. & Duncan I. J. H. In-Prep. Fish welfare in aquaculture. *Journal of Applied Animal Welfare Science*.

Cawley, G. 1993. Welfare aspects of aquatic veterinary medicine. In: Brown, L. (ed). *Aquaculture for veterinarians: fish husbandry and medicine*, Pergamon Press, Chicago, USA, p. 169-173.

FAWC. 1996. Report on the welfare of farmed fish. Farm Animal Welfare Council, Surrey.

Fish Veterinary Society. 1993. Guidelines on the welfare of farmed fish. Fish Veterinary Society Publication.

- Gregersen F. 1999. Research on fish welfare: small efforts prevent stress and aggression. Fiskeriforskning Info., Norwegian Institute of Fisheries and Aquaculture Ltd. May, No. 6.
- Hatt J. 1998. Animal rights growing concern for aquaculturists. Northern Aquaculture May, 3.
- Lymbery P. 1992. The welfare of farmed fish. Compassion in World Farming, Hants. Cattleshall Printing Services.
- Midtlyng P. J. 1997. Vaccinated fish welfare: protection versus side-effects. Developments of Biological Standardization 90, 371-379.
- Needham, T. 1990. Do fish have rights? Canadian Aquaculture September/October, p. 45-46.
- Needham E. A. & Lehman H. 1991. Farming salmon ethically. Journal of Agricultural and Environmental Ethics 14, 78-81.
- Neukirch M. 1994. Legitimate aspects relevant to animal protection on killing fish. Deutsche Tierärztliche Wochenschrift 101, 316-319.
- Peters G. 1990. Problems concerning animal protection laws in connection with mass culture of fishes. Deutsche Tierärztliche Wochenschrift 97, 157-160.
- Rollin B. 2000. Animal ethics - an emerging force to be reckoned with. Northern Aquaculture 6(12), 9.
- Schwedler T. E. & Johnson S. K. 1997. Responsible care and health maintenance of fish in commercial aquaculture. In: *Animal Welfare Issues Compendium* (Facilitated by R.D. Reynnells & B.R. Eastwood), United States Department of Agriculture.

Pain

- Bateson P. 1991. Assessment of pain in animals. Animal Behaviour 42, 827-839.
- Bateson, P. 1992. Do animals feel pain? New Scientists. April.
- Bennett G. J. 2000. Update on the neurophysiology of pain transmission and modulation: focus on the NMDA-receptor. Journal of Pain and Symptom Management, Supplement. 19, S2-S6.
- Brown L. A. 1985. The clinical measurement of pain, distress and discomfort in fish. In: Symposia Series I, The detection and relief of pain in animals. pp. 98-100. The British Veterinary Association Animal Welfare Foundation.
- Chapman R. C. & Nakamura Y. 1999. A passion of the soul: an introduction to pain for consciousness researchers. Consciousness and Cognition 8, 391-422.
- Chervova L. S. 1997. Pain sensitivity and behavior of fishes. Journal of Ichthyology 37, 98-102.
- Gregory N. 1999. Do fish feel pain? Surveillance 26, 8-10.

- Kestin S. C. 1994. Pain and stress in fish. Royal Society for the Prevention of Cruelty to Animals. RSPCA, Horsham, Sussex.
- Kitchell R. L. & Guinan M. J. 1990. The nature of pain in animals. In: *The Experimental Animal in Biomedical Research, Volume 1* (ed. by B.E. Rollin & M.L. Kesel), pp. 185-204. CRC Press, Inc., Boca Raton.
- Kitchell R. L. & Johnson R. D. 1985. Assessment of pain in animals. In: *Animal Stress* (ed. by G.P. Moberg), pp. 113-140. American Physiological Society. Bethesda, Maryland.
- Morton, D.B. and P.H.M. Griffiths. 1985. Guidelines on the recognition of pain, distress and discomfort in experimental animals and an hypothesis for assessment. *Vet. Record* 116: 431-436.
- Rose M. & Adams D. 1989. Evidence for pain and suffering in other animals. In: *Animal Experimentation: The Consensus Changes* (ed. by G. Langley), pp. 42-71. Chapman and Hall, New York.
- Sanford, J., R. Ewbank, V. Molony, W.D. Tavernor and O. Uvarov. 1986. Guidelines for the recognition and assessment of pain in animals. *Vet. Record* 118: 334-338.
- Stevens, E.D. 2009. "Pain" and analgesia in fish: what we know, what we don't know, and what we need to know before using analgesics in fish. pp. 115-124 in: Blue sky to deep water: the reality and the promise. ANZCCART, Wellington. http://www.royalsociety.org.nz/Site/About/Our_structure/advisory/anzccart/conf2008/Proceedings_2008_Conference.aspx
- Stoskopf M. K. 1994. Pain and analgesia in birds, reptiles, amphibians, and fish. *Investigative Ophthalmology & Visual Science* 35, 775-780.
- Treede R.-D., Kenshalo D. R., Gracely R. H. & Jones A. K. P. 1999. The cortical representation of pain. *Pain* 79, 105-111.
- Wright, E.M., K.L. Marcella and J.F. Woodson. 1985. Animal pain: Evaluation and control. *Lab Animal* 120: 21-26.
- Zieglgänsberger W. 1986. Central control of nociception. In: *Handbook of Physiology. Volume 4; The Nervous System* (e.d by V.B. Mountcastle, F.E. Bloom & S.R. Geiger), pp. 581-645. American Physiological Society. Bethesda, Maryland.
- Zimmerman, M. 1986. Assessing pain in farm animals. Eds. I.J.H. Duncan and V. Moliny. Proc. Commission of European Communities Workshop. October.

Stress

Adams M. S. 1990. Status and use of biological indicators for evaluating the effects of stress on fish. American Fisheries Society Symposium 8, 1-8.

Anderson, D.P. 1990. Immunological indicators: effects of environmental stress on immune protection and disease outbreaks. In: Biological indicators of Stress in Fish, Adams, S.M. (Ed.) American Fisheries Society Symposium 8, Bethesda, Maryland, p. 38-50.

Asterita, M.F. 1985. The physiology of stress. Human Sciences Press Inc., New York, p. 264.

Barcellos L. J. G., Nicholaiewsky S., Souza S. M. G. & Lulhier F. 1999. Plasmatic levels of cortisol in the response to acute stress in Nile tilapia, *Oreochromis niloticus* (L.), previously exposed to chronic stress. Aquaculture Research 30, 437-444.

Barton, B.A. and G.K. Iwama. 1991. Physiological changes in fish from stress in aquaculture with emphasis on the response and effects of corticosteroids. Annual Rev. of Fish Diseases, p. 3-16.

Barton B. A. 1997. Stress in finfish: past, present and future - a historical perspective. In: *Fish Stress and Health in Aquaculture* (ed. by G.K. Iwama, A.D. Pickering, J.P. Sumpter & C.B. Schreck), pp.1-33. Society for Experimental Biology; seminar series 62. Cambridge University Press, Cambridge.

Barton B. A. & Schreck C. B. 1987. Metabolic cost of acute physical stress in juvenile steelhead. Transactions of the American Fisheries Society 116, 257-263.

Goede, R.W. and B.A. Barton. 1990. Organismic indices and an autopsy-based assessment as indicators of health and condition of fish. In: Biological Indicators of Stress in Fish, Adams, S.M. American Fisheries Society Symposium 8, Bethesda, Maryland, p. 93-108.

Gregory T. R. W. C. M. 1999. The effects of chronic plasma cortisol elevation on the feeding behaviour, growth, competitive ability, and swimming performance of juvenile rainbow trout. Physiological and Biochemical Zoology 72, 286-295.

Iwama, G.K., J.D. Morgan and B.A. Barton. 1995. Simple field methods for monitoring stress and general condition of fish. Aquaculture Research 26: 273-282.

Jeney G., Galeotti M., Volpatti D., Jeney Z. & Anderson D. 1997. Prevention of stress in rainbow trout (*Oncorhynchus mykiss*) fed diets containing different doses of glucan. Aquaculture 154, 1-15.

Levine, S. 1985. A definition of stress? In: Animal Stress, Moberg, G.P. American Physiological Society, Bethesda, Maryland, p. 51-69.

- Mazeaud M. M., Mazeaud F. & Donaldson E. M. 1977. Primary and secondary effects of stress in fish: Some new data with a general review. *Transactions of the American Fisheries Society* 106, 201-212.
- McDonald D. G. & Robinson J. G. 1993. Physiological responses of lake trout to stress: effects of water hardness and genotype. *Transactions of the American Fisheries Society* 122, 1146-1155.
- Moberg, G.P. 1985. Animal stress. In: *Animal Stress*, Moberg, G.P. American Physiological Society, Bethesda, Maryland. p. 324.
- Olla B. L., Davis M. W. & Schreck C. B. 1992. Comparison of predator avoidance capabilities with corticosteroid levels induced by stress in juvenile coho salmon. *Transactions of the American Fisheries Society* 121, 544-547.
- Olla B. L., Davis M. W. & Schreck C. B. 1995. Stress-induced impairment of predator evasion and non-predator mortality in pacific salmon. *Aquaculture Research* 26, 393-398.
- Pagnotta A., Brooks L. & Milligan L. 1994. The potential regulatory roles of cortisol in recovery from exhaustive exercise in rainbow trout. *Canadian Journal of Zoology* 72, 2136-2146.
- Peters, G., M. Faisal, T. Lang and I. Ahmed. 1988. Stress caused by social interaction and its effect on susceptibility to *Aeromonas hydrophila* infection in rainbow trout *Salmo gairdneri*. *Dis. Aquat. Organ.* 4: 83-89.
- Pickering, A.D. 1981. Introduction: The concept of biological stress. In: *Stress and Fish*, Pickering, A.D. Academic Press, London, p. 1-9.
- Pickering, A.D. 1993. Stress and adaptation: husbandry and stress. In: *Recent Advances in Aquaculture IV*. Muir, J.F. and R.J. Roberts (Eds.), Blackwell Scientific Publications, London, p. 155-169.
- Pickering A. D. & Pottinger T. G. 1989. Stress responses and disease resistance in salmonid fish: effects of chronic elevation of plasma cortisol. *Fish Physiology and Biochemistry* 7, 253-258.
- Pickering A. D., Pottinger T. G. & Christie P. 1982. Recovery of the brown trout, *Salmo trutta* L., from acute handling stress: a time-course study. *Journal of Fish Biology* 20, 229-244.
- Pottinger T. G. & Pickering A. D. 1997. Genetic basis to the stress response: selective breeding for stress-tolerant fish. In: *Fish Stress and Health in Aquaculture* (ed. by G.K. Iwama, A.D. Pickering, J.P. Sumpter & C.B. Schreck), pp. 171-193. Society for Experimental Biology; seminar series 62. Cambridge University Press, Cambridge.
- Rice, J.A. 1990. Bioenergetics modeling approaches to evaluation of stress in fishes. In: *Biological Indicators of Stress in Fish*, Adams, S.M. (Ed.) American Fisheries Society Symposium 8, Bethesda, Maryland, p. 80-92.
- Scherer E. 1992. Behavioural responses as indicators of environmental alterations: approaches, results, developments. *Journal of Applied Ichthyology* 8, 122-131.

- Schreck C. B. 1981. Stress and compensation in teleostean fishes: response to social and physical factors. In: *Stress and Fish* (ed. by A.D. Pickering), pp. 295-321. Academic Press Inc., New York.
- Schreck C. B. 1982. Stress and rearing of salmonids. *Aquaculture* 28, 241-249.
- Schreck C. B. 1990. Physiological, behavioral, and performance indicators of stress. *American Fisheries Society Symposium* 8, 29-37.
- Schreck, C.B., A.G. Maule and S.L. Kaattari. 1993. Stress and disease resistance. In: *Recent Advances in Aquaculture IV*. Muir, J.F. and R.J. Roberts (Eds.), Blackwell Scientific Publications, London, p.170-175.
- Schreck C. B., Olla B. L. & Davis M. W. 1997. Behavioural responses to stress. In: *Fish Stress and Health in Aquaculture* (ed. by G.K. Iwama, A.D. Pickering, J.P. Sumpter & C.B. Schreck), pp. 145-170. Society for Experimental Biology; seminar series 62. Cambridge University Press, Cambridge.
- Sharpe C. S., Thompson D. A., Blankenship H. L. & Schreck C. B. 1997. Effects of routine handling and tagging procedures on physiological stress responses in juvenile chinook salmon. *The Progressive Fish-Culturist* 60, 81-87.
- Strange R. J. & Cech J. J. 1992. Reduced swimming performance of striped bass after confinement stress. *Transactions of the American Fisheries Society* 121, 206-210.
- Strange R. J. & Schreck C. B. 1978. Anesthetic and handling stress on survival and cortisol concentration in yearling chinook salmon (*Oncorhynchus tshawytscha*). *Journal of the Fisheries Research Board of Canada* 35, 345-349.
- Sumpter J. P. 1997. The endocrinology of stress. In: *Fish Stress and Health in Aquaculture* (ed. by G.K. Iwama, A.D. Pickering, J.P. Sumpter & C.B. Schreck), pp. 95-118. Society for Experimental Biology; seminar series 62. Cambridge University Press, Cambridge.
- Thomas, P. 1990. Molecular and biochemical responses of fish to stressors and their potential use in environmental monitoring. In: *Biological Indicators of Stress in Fish*, Adams, S.M. (Ed.) *American Fisheries Society Symposium* 8, Bethesda, Maryland, p. 9-28.
- Vijayan M. M. & Moon T. W. 1992. Acute handling stress alters hepatic glycogen metabolism in food deprived rainbow trout (*Oncorhynchus mykiss*). *Canadian Journal of Fisheries and Aquatic Sciences* 49, 2260-2266.
- Wardle, C.S. 1981. Physiological stress in captive fish. In: *Aquarium Systems*, Hawkins, A.D. (Ed.), Academic Press, London, p. 403-414.
- Wedemeyer G. A. & McLeay D. J. 1981. Methods for determining the tolerance of fishes to environmental stressors. In: *Stress and Fish* (ed. by A.D. Pickering), pp. 247-275. Academic Press Inc., New York.

Cognitive Ability, Fear and Awareness in Fish

- Bisazza A., De Santi A. & Vallortigara G. 1999. Laterality and cooperation: mosquitofish move closer to a predator when the companion is on their left side. *Animal Behaviour* 57, 1145-1149.
- Bisazza A., Pignatti R. & Vallortigara G. 1997. Detour tests reveal task- and stimulus-specific behavioural lateralization in mosquitofish (*Gambusia holbrooki*). *Behavioural Brain Research* 89, 237-242.
- Bisazza A., Rogers L. J. & Vallortigara G. 1998. Origins of cerebral asymmetry: a review of evidence of behavioural and brain lateralization in fishes, reptiles and amphibians. *Neuroscience and Biobehavioural Reviews* 22, 411-426.
- Bunge M. & Ardila R. 1987. *Philosophy of Psychology*. Springer-Verlag, New York.
- Canfield J. G. & Rose G. J. 1993. Activation of mauthner neurons during prey capture. *Journal of Comparative Physiology A* 172, 611-618.
- Cantalupo C., Bisazza A. & Vallortigara G. 1995. Lateralization of predator-evasion response in a teleost fish (*Girardinus falcatus*). *Neuropsychologia* 33, 1637-1646.
- Csanyi V. 1986. Ethological analysis of predator avoidance by the paradise fish (*Macropodus opercularis* L.): II. Key stimuli in avoidance learning . *Animal Learning & Behavior* 14, 101-109.
- Csányi V. 1993. How genetics and learning make a fish an individual: a case study on the paradise fish. In: *Perspectives in Ethology. Volume 10; Behavior and Evolution* (ed. by P.P.G. Bateson, P.H. Klopher & N.S. Thompson), pp. 1-51. Plenum Press, New York .
- Csányi V., Csizmadia G. & Miklosi A. 1989. Long-term memory and recognition of another species in the paradise fish. *Animal Behaviour* 37, 908-911.
- Csányi V. & Dóka A. 1993. Learning interactions between prey and predator fish. *Marine and Freshwater Behaviour and Physiology* 23, 63-78.
- Csányi V. & Lovász F. 1987. Key stimuli and the recognition of the physical environment by the paradise fish *Macropodus opercularis*. *Animal Learning & Behavior* 15, 379-381.
- Davis R. E. & Klinger P. D. 1994. NMDA receptor antagonist MK-801 blocks learning of conditioned stimulus-unconditioned stimulus contiguity but no fear of conditioned stimulus in goldfish (*Carassius auratus* L.). *Behavioral Neuroscience* 108, 935-940.
- Eaton R. C., Lavender W. A. & Wieland C. M. 1981. Identification of Mauthner-initiated response in goldfish: evidence from simultaneous cinematography and electrophysiology. *Journal of Comparative Physiology* 144, 521-531.

- Eaton R. C., Lavender W. A. & Wieland C. M. 1982. Alternative neural pathways initiate fast-start responses following lesions of the Mauthner neuron in goldfish. *Journal of Comparative Physiology* 145, 485-496.
- Eaton R. C. & Nissanov J. 1985. A review of Mauthner-initiated escape behaviour and its possible role in hatching in the immature zebrafish, *Brachydanio rerio*. *Environmental Biology of Fishes* 12, 265-279.
- Facchin L., Bisazza A. & Vallortigara G. 1999. What causes lateralization of detour behavior in fish? evidence for asymmetries in eye use. *Behavioural Brain Research* 103, 229-234.
- Hall D. & Suboski D. 1995. Visual and olfactory stimuli in learned release of alarm reactions by zebra danio fish (*Brachydanio rerio*). *Neurobiology of Learning and Memory* 63, 229-240.
- Harper D. G. & Blake R. W. 1990. Fast-start performance of rainbow trout *Salmo gairdneri* and northern pike *Esox Lucius*. *Journal of Experimental Biology* 150, 321-342.
- Höglund E., Balm P. H. & Winberg S. 2000. Skin darkening, a potential social signal in subordinate Arctic charr (*Salvelinus alpinus*): the regulatory role of brain monoamines and pro-opiomelanocortin-derived peptides. *Journal of Experimental Biology* 203, 1711-1721.
- Höjesjö J., Johnsson J. I. & Axelsson M. 1999. Behavioural and heart rate responses to food limitation and predation risk: an experimental study on rainbow trout. *Journal of Fish Biology* 55, 1009-1019.
- Johnsson J. I. 1997. Individual recognition affects aggression and dominance relations in rainbow trout, *Oncorhynchus mykiss*. *Ethology* 103, 267-282.
- Johnsson J. I. & Åkerman A. 1998. Watch and learn: preview of the fighting ability of opponents alter contest behaviour in rainbow trout. *Animal Behaviour* 56, 771-776.
- Jones R. B. 1997. Fear and distress. In: *Animal Welfare* (ed. by M.C. Appleby & B.O. Hughes), pp. 75-87. CAB International. University Press, Cambridge.
- Kilian A., von Fersen L. & Güntürkün O. 2000. Lateralization of visuospatial processing in the bottlenose dolphin (*Tursiops truncatus*). *Behavioural Brain Research* 116, 211-215.
- Lachlan R. F., Crooks L. & Laland K. N. 1998. Who follows whom? Shoaling preferences and social learning of foraging information in guppies. *Animal Behaviour* 56, 181-190.
- López C. J., Broglio C., Rodríguez F., Thinus-Blanc C. & Salas C. 2000. Reversal learning deficit in a spatial task but not in a cued one after telencephalic ablation in goldfish. *Behavioural Brain Research* 109, 91-98.
- López J. C., Bingman V. P., Rodríguez F., Gómez Y. & Salas C. 2000. Dissociation of place and cue learning by telencephalic ablation in goldfish. *Behavioral Neuroscience* 114, 687-699.
- Losey Jr G. S. & Margules L. 1974. Cleaning symbiosis provides a positive reinforcer for fish. *Science* 184, 179-180.
- Mendl M. 1999. Performing under pressure: stress and cognitive function. *Applied Animal Behaviour*

Science 65, 221-244.

Metcalfe N. B., Taylor A. C. & Thorpe J. E. 1995. Metabolic rate, social status and life-history strategies in Atlantic salmon. Animal Behaviour 49, 431-436.

Miklósi Á. & Andrew R. J. 1999. Right eye use associated with decision to bite in zebrafish. Behavioural Brain Research 105, 199-205.

Nesse R. M. 2000. Is depression and adaptation? Archives of General Psychiatry 57, 14-20.

O'Connor K. I., Metcalfe N. B. & Taylor A. C. 1999. Does darkening signal submission in territorial contests between juvenile Atlantic salmon, *Salmo salar*? Animal Behaviour 58, 1269-1276.

O'Connor K. I., Metcalfe N. B. & Taylor A. C. 2000. Familiarity influences body darkening in territorial disputes between juvenile salmon. Animal Behaviour 59, 1095-1101.

Olla B. L. & Davis M. W. 1989. The role of learning and stress in predator avoidance of hatchery-reared coho salmon (*Oncorhynchus kisutch*) juveniles. Aquaculture 76, 209-214.

Øverli Ø., Harris C. A. & Winberg S. 1999. Short-term effects of fights for social dominance and the establishment of dominant-subordinate relationships on brain monoamines and cortisol in rainbow trout. Brain, Behaviour and Evolution 54, 263-275.

Øverli Ø., Winberg S., Damsgård B. & Jobling M. 1998. Food intake and spontaneous swimming activity in Arctic char (*Salvelinus alpinus*): role of brain serotonergic activity and social interactions. Canadian Journal of Zoology 76, 1366-1370.

Pitcher T. J. 1993. Behaviour of Teleost Fishes, 2nd edition. Chapman & Hall, London.

Popper A. N. & Carlson T. J. 1998. Application of sound and other stimuli to control fish behavior. Transactions of the American Fisheries Society 127, 673-707.

Schaerer S. & Kirschfeld K. 2000. The role of background movement in goldfish vision. Journal of Comparative Physiology A 186, 583-593.

Schreck C. B., Jonsson L., Feist G. & Reno P. 1995. Conditioning improves performance of juvenile chinook salmon, *Oncorhynchus tshawytscha*, to transportation stress. Aquaculture 135, 99-110.

Topál J. & Csányi V. 1999. Interactive learning in the paradise fish (*Macropodus opercularis*): an ethological interpretation of the second-order conditioning paradigm. Animal Cognition 2, 197-206.

Vallortigara G., Rogers L. J. & Bisazza A. 1999. Possible evolutionary origins of cognitive brain lateralization. Brain Research Reviews 30, 164-175.

Varner G. E. 1998. *In Nature's Interests? Interests, Animal Rights, and Environmental Ethics*. Environmental Ethics and Science Policy Series, Oxford University Press, U.S.A.

Wainwright P. C. 1986. Motor correlates of learning behaviour: feeding on novel prey by pumpkinseed sunfish (*Lepomis gibbosus*). Journal of Experimental Biology 126, 237-247.

Webb P. W. 1986. Effect of body form and response threshold on the vulnerability of four species of

teleost prey attacked by largemouth bass (*Micropterus salmoides*). Canadian Journal of Fisheries and Aquatic Sciences 43, 763-771.

Wood-Gush D. G. M., M.S. Dawkins & R. Ewbank. 1981. *Self-Awareness in Domesticated Animals*. Universities Federation for Animal Welfare. Potters Bar, England.

Zayan R. 1991. The specificity of social stress. Behavioural Processes 25, 81-93.

Anatomical, Pharmacological and Neurophysiological Studies Pertaining to Pain, Fear and Stress in Fish

Bernstein, J.J. 1970. Anatomy and physiology of the central nervous system. In: Hoar, W.S. and Randall, D.J. (eds) Fish Physiology, Vol. IV, Academic Press, New York, p. 1-78.

Butler A. B. 2000. Topography and topology of the teleost telencephalon: a paradox resolved. Neuroscience Letters 293, 95-98.

Carruth L. L., Jones R. E. & Norris D. O. 2000. Cell density and intracellular translocation of glucocorticoid receptor-immunoreactive neurons in the Kokanee salmon (*Oncorhynchus nerka knerri*) brain, with an emphasis on the olfactory system. General and Comparative Endocrinology 117, 66-76.

Cameron, A.A., P.J. Snow and M.B. Plenderleith. 1990. Organization of the spinal cord in four species of elasmobranch fish: Cytoarchitecture and distribution of serotonin and selected neuropeptides. J. Comp. Neurol. 297: 201-218.

Coggeshall, R.E., R.B. Leonard, M.L. Applebaum and W.D. Willis. 1978. Organization of peripheral nerves and spinal roots of the Atlantic stingray, *Dasyatis sabina*. J. Neurophysiol. 41: 97-107.

Corrêa S. A. L., Corrêa F. M. A. & Hoffmann A. 1998. Stereotaxic atlas of the telencephalon of the weakly electric fish *Gymnotus carapo*. Journal of Neuroscience Methods 84, 93-100.

Correia, A.D., Cunha, S.R. and Stevens E. Don. 2009. A behavioural fish model of nociception for testing new analgesic drugs. AMINO ACIDS 37(Suppl. 1): 75-75.

Davis R. E. & Kassel J. 1983. Behavioral functions of the teleostean telencephalon. In: *Fish Neurobiology. Volume 2: Higher Brain Areas and Functions* (ed. by R.E. Davis & R.G. Northcutt), pp. 238-263. University of Michigan Press, Ann Arbor.

Demski L. S. 1983. Behavioural effects of electrical stimulation of the brain. In: *Fish Neurobiology. Volume 2: Higher Brain Areas and Functions* (ed. by R.E. Davis and R.G. Northcutt), pp. 317-359. University of Michigan Press, Ann Arbor.

Devor A. 2000. Is the cerebellum like cerebellar-like structures? Brain Research Reviews 34, 149-156.

- Echteler S. M. & Saidel W. M. 1981. Forebrain connections in the goldfish support telencephalic homologies with land vertebrates. *Science* 212, 683-684.
- Ehrensing R. H., Michell G. F. & Kastin A. J. 1982. Similar antagonism of morphine analgesia by MIF-1 and naloxone in *Carassius auratus*. *Pharmacology Biochemistry and Behavior* 17, 757-761.
- Fibiger H. C. & Phillips A. G. 1986. Reward, motivation, cognition: psychobiology of mesotelencephalic dopamine systems. In: *Handbook of Physiology. Volume 4; The Nervous System* (e.d by V.B. Mountcastle, F.E. Bloom & S.R. Geiger), pp. 647-675. American Physiological Society. Bethesda, Maryland.
- Finger T. E. 1980. Nonolfactory sensory pathway to the telencephalon in a teleost fish. *Science* 210, 671-673.
- Finger T. E. 1983. Organization of the teleost cerebellum. In: *Fish Neurobiology. Volume 1: Brain Stem and Sense Organs* (ed. by R.G. Northcutt & R.E. Davis) pp.261-284. University of Michigan Press, Ann Arbor.
- Goping G., Pollard H. B., Adeyemo O. M. & Kuijpers G. A. J. 1995. Effect of MPTP on dopaminergic neurons in the goldfish brain: a light and electron microscope study. *Brain Research* 687, 35-52.
- Guthrie D. M. 1983. Integration and control by the central nervous system. In: *Control Processes in Fish Physiology* (ed. by J.C. Rankin, T.J. Pitcher & R.T. Duggan), pp. 130-154. Croom Helm, London.
- Hatta K. & Korn H. 1999. Tonic inhibition alternates in paired neurons that set direction of fish escape reaction. *Proceedings of the National Academy of Sciences of the United States States of America* 96, 12090-12095.
- Hildebrand M. 1995. *Analysis of Vertebrate Structure, Fourth edition*. John Wiley & Sons, Inc., New York .
- Hon W. K. & Ng T. B. 1986. Hormones with adrenocorticotrophic and opiate-like activities from the carp (*Cyprinus carpio*) pituitary. *Comparative Biochemistry and Physiology* 85C, 443-448.
- Jansen G. A. & Green N. M. 1970. Morphine metabolism and morphine tolerance in goldfish. *Anesthesiology* 32, 231-235.
- Jr. Bradford M. R. 1995. Comparative aspects of forebrain organization in the ray-finned fishes: touchstones or not? *Brain, Behavior and Evolution* 46, 259-274.
- Kotrschal K., van Staaden M. J. & Huber R. 1998. Fish brains: evolution and environmental relationships. *Reviews in Fish Biology and Fisheries* 8, 373-408.
- Le Moal M. & Simon H. 1991. Mesocorticolimbic dopaminergic network: functional and regulatory roles. *Physiological Reviews* 71, p155.
- Lett B. T. & Grant V. L. 1989. The hedonic effects of amphetamine and pentobarbital in goldfish. *Pharmacology Biochemistry & Behavior* 32, 355-356.
- Matthews G. & Wickelgren W. O. 1978. Trigeminal sensory neurons of the sea lamprey. *Journal of*

Comparative Physiology 123, 329-333.

- Mattioli R., Aguilar C. & Vasconcelos L. 1995. Reinforcing properties of the neuropeptide substance P in *Carassius auratus*: evidence of dopaminergic system involvement. Pharmacology Biochemistry and Behavior 50, 77-81.
- Mattioli R., Santangelo E. M., Costa A. C. C. & Vasconcelos L. 1997. Substance P facilitates memory in goldfish in an appetitively motivated learning task. Behavioural Brain Research 85, 117-120.
- Mok E. Y. M. & Munro A. D. 1998. Effects of dopaminergic drugs on locomotor activity in teleost fish of the genus *Oreochromis* (Cichlidae): involvement of the telencephalon . Physiology and Behavior 64, 227-234.
- Munro A. D. 1986. The effects of apomorphine, *d*-amphetamine and chloropromazine on the aggressiveness of isolated *Aequidens pulcher* (Teleostei, Cichlidae). Psychopharmacology 88, 124-128.
- Munro A. D. & Dodd J. M. 1983. Forebrain of fishes: neuroendocrine control mechanisms. In: *Progress in Nonmammalian Brain Research, Volume III* (ed. by G. Nisticò & L. Bolis), pp. 2-78. CRC Press Inc, Florida.
- Newby, N.C., Wilkie, M.P., and Stevens E. Don. 2009. Morphine uptake, disposition, and analgesic efficacy in the common goldfish (*Carassius auratus*) Canadian Journal of Zoology 87(5): 388-399.
- Newby, N.C. and Stevens E. Don. 2009. The effects of the acetic acid "pain" test on feeding, swimming, and respiratory of rainbow trout (*Oncorhynchus mykiss*): A critique on Newby and Stevens (2008) - Response. Applied Animal Behaviour Science. 116(1): 97-99
- Newby, N.C., Robinson, J.W., Vachon, P., Beaudry, F., and Stevens, E. Don. 2008. Pharmacokinetics of morphine and its metabolites in freshwater rainbow trout (*Oncorhynchus mykiss*). J. Vet. Pharmacol. Therap. 31: 117-127. doi: 10.1111/j.1365-2885.2008.00939.x
- Newby, N.C. and Stevens E. Don. 2008. The effects of the acetic acid "pain" test on feeding, swimming, and respiratory responses of rainbow trout (*Oncorhynchus mykiss*). Applied Animal Behaviour Science 114: 260-269
- Newby, N.C., Binder, T.R., Stevens, E. Don. 2007. Passive integrated transponder (PIT) tagging did not negatively affect the short-term feeding behaviour or swimming performance of juvenile rainbow trout. Transactions of American Fisheries Society 136: 341-345.
- Stevens, E. Don, Balahura, R.J. 2007. Aspects of morphine chemistry important to persons working with cold-blooded animals, especially fish. Comparative Medicine. 57(2):161-166.
- Newby, N.C., Gamperl, A.K., Stevens, E. Don. 2007. Cardiorespiratory effects and efficacy of morphine sulfate in winter flounder. American Journal of Veterinary Research. 68(6):592-597.
- Newby, N.C., Mendonça, P.C., Gamperl, K.A., Stevens, E. Don. 2006. Pharmacokinetics of morphine in fish: winter flounder (*Pseudopleuronectes americanus*) and seawater-acclimated rainbow trout (*Oncorhynchus mykiss*). Comparative Biochemistry and Physiology Part C. 143: 275-283.
- Ng T. B. & Chan T. H. 1990. Adrenocorticotropin-like and opiate-like materials in the brain of the red grouper *Epinephelus akaara* (Teleostei: serranidae). Comparative Biochemistry and Physiology 95C, 159-162.

- Nieuwenhuys R. 1982. An overview of the organization of the brain of actinopterygian fishes. *American Zoologist* 22, 287-310.
- Ohnishi K. 1997. Effects of telencephalic ablation on short-term memory and attention in goldfish. *Behavioural Brain Research* 86, 191-199.
- Overmier J. B. & Hollis K. L. 1983. The teleostean telencephalon in learning. In: *Fish Neurobiology. Volume 2: Higher Brain Areas and Functions* (ed. by R.E. Davis & R.G. Northcutt), pp. 265-283. University of Michigan Press, Ann Arbor.
- Overmier J. B. & Papini M. R. 1986. Factors modulating the effects of teleost telencephalon ablation on retention, relearning, and extinction of instrumental avoidance behavior. *Behavioral Neuroscience* 100, 190-199.
- Pavlov D. S. & Kasumyan A. O. 1995. A review of Russian studies on the behavior and sensory systems of fishes. Report 3. *Journal of Ichthyology* 35, 806-815.
- Piront M. & Schmidt R. 1988. Inhibition of long-term memory formation by anti-ependymin antisera after active shock-avoidance learning in goldfish. *Brain Research* 442, 53-62.
- Pollard H. B., Kuijpers G. A., Adeyemo O. M., Youdim M. B. H. & Goping G. 1996. The MPTP-induced parkinsonian syndrome in the goldfish is associated with major cell destruction in the forebrain and subtle changes in the optic tectum. *Experimental Neurology* 142, 170-178.
- Prechtel J. C., von der Emde G., Wolfart J., Karamürsel S., Akoev G. N., Andrianov Y. N. & Bullock T. H. 1998. Sensory processing in the pallium of a mormyrid fish. *Journal of Neuroscience* 18, 7381-7393.
- Previc F. H. 1999. Dopamine and the origins of human intelligence. *Brain and Cognition* 41, 299-350.
- Rolls E. T. 2000. Précis of *The brain and emotion*. *Behavioral and Brain Sciences* 23, 177-234.
- Rovainen C. M. & Yan Q. 1985. Sensory responses of dorsal cells in the lamprey brain. *Journal of Comparative Physiology A* 156, 181-183.
- Salas C., Broglia C., Rodríguez F., López J. C., Portavella M. & Torres B. 1996. Telencephalic ablation in goldfish impairs performance in a 'spatial constancy' problem but not in a cued one. *Behavioural Brain Research* 79, 193-200.
- Salas C., Rodríguez F., Vargas J. P., Durán E. & Torres B. 1996. Spatial learning and memory deficits after telencephalic ablation in goldfish trained in place and turn maze procedures. *Behavioral Neuroscience* 110, 965-980.
- Savage G. 1980. The fish telencephalon and its relation to learning. In: *Comparative Neurology of the Telencephalon* (ed. by S.O.E. Ebbesson), pp.129-174. Plenum Press, New York.
- Schmidt R. 1995. Cell-adhesion molecules in memory formation. *Behavioural Brain Research* 66, 65-72.

Snow, P.J., M.B. Plenderleith and L.L. Wright. 1993. Quantitative study of primary sensory neurone populations of three species of elasmobranch fish. *J. Comp. Neurol.* 334: 97-103.

Sovrano V. A., Rainoldi C., Bisazza A. & Vallortigara G. 1999. Roots of brain specializations: preferential left-eye use during mirror-image inspection in six species of teleost fish. *Behavioural Brain Research* 106, 175-180.

Van de Kar L. D. & Blair M. L. 1999. Forebrain pathways mediating stress-induced hormone secretion. *Frontiers in Neuroendocrinology* 20, 1-48.

Vargas J. P., Rodríguez F., López J. C., Arias J. L. & Salas C. 2000. Spatial learning-induced increase in the argyrophilic nucleolar organizer region of dorsolateral telencephalic neurons in goldfish. *Brain Research* 865, 77-84.

Winberg S., Carter C. G., McCarthy I. D., He Z.-Y., Nilsson G. E. & Houlihan D. F. 1993. Feeding rank and brain serotonergic activity in rainbow trout *Oncorhynchus mykiss*. *Journal of Experimental Biology* 179, 197-211.

Winberg S. & Lepage O. 1998. Elevation of brain 5-HT activity, POMC expression, and plasma cortisol in socially subordinate rainbow trout. *American Journal of Physiology* 274, R645-R654.

Winberg S. & Nilsson G. E. 1993. Time course of changes in brain serotonergic activity and brain tryptophan levels in dominant and subordinate juvenile arctic charr. *Journal of Experimental Biology* 179, 181-195.

Zottoli S. J., Newman B. C., Rieff H. I. & Winters D. C. 1999. Decrease in occurrence of fast startle responses after selective Mauthner cell ablation in goldfish (*Carassius auratus*). *Journal of Comparative Physiology A* 184, 207-218.

Zupanc G. K. H. 1997. The preglomerular nucleus of gymnotiform fish: relay station for conveying information between telencephalon and diencephalon. *Brain Research* 761, 179-191.

Husbandry, Transportation and Slaughter Methods

Abbott J. C. & Dill L. M. 1985. Patterns of aggressive attack in juvenile steelhead trout (*Salmo gairdneri*). *Canadian Journal of Fisheries and Aquatic Sciences* 42, 1702-1706.

Alanärä A. & Brännäs E. 1996. Dominance in demand-feeding behaviour in Arctic charr and rainbow trout: the effect of stocking density. *Journal of Fish Biology* 48, 242-254.

- Balarin, J.D. 1984. Tilapia. In: Evolution of Domesticated Animals, I.L. Mason (Ed.). Longman, London/Condon Group Ltd., New York, p. 391-397.
- Bardach, J., R. Magnuson, R. May and J. Reihart (Eds.). 1980. Fish behaviour and its use in the capture and culture of fishes. Proceedings of the Conference on the Physiological and Behavioral Manipulation of Food Fish as Production and Management Tools, Ballagio, Italy, Nov 3, 1977, p. 512.
- Barton B. A. 2000. Salmonid fishes differ in their cortisol and glucose responses to handling and transport stress. North American Journal of Aquaculture 62, 12-18.
- Barton B. A. & Peter R. E. 1982. Plasma cortisol stress response in fingerling rainbow trout, *Salmo gairdneri* Richardson, to various transport conditions, anaesthesia, and cold shock. Journal of Fish Biology 20, 39-51.
- Barton B. A., Schreck C. B. & Fowler L. G. 1988. Fasting and diet content affecting stress-induced changes in plasma glucose and cortisol in juvenile chinook salmon. The Progressive Fish-Culturist 50, 16-22.
- Bhujel R. C. 2000. A review of strategies for the management of Nile tilapia (*Oreochromis niloticus*) broodfish in seed production systems, especially hapa-based systems. Aquaculture 181, 37-59.
- Bullock, A.M. 1988. Solar ultraviolet radiation: A potential environmental hazard in the cultivation of farmed finfish. In: Recent Advances in Aquaculture, Muir, J.F. and R.J. Roberts (Eds.), Croom Helm Publishers, London, p. 139-224.
- Burgov, L. 1992. Rainbow trout culture in submersible cages near offshore oil platforms. Aquaculture 100: 167-174.
- Carmichael G. J. 1984. Long distance truck transport of intensively reared largemouth bass. The Progressive Fish-Culturist 46, 111-115.
- Casebolt D. B., Speare D. J. & Horney B. S. 1998. Care and use of fish as laboratory animals: current state of knowledge. Laboratory Animal Science 48, 124-136.
- CCAS (Canadian Council on Animal Care). 1994. Resource. Vol. 18, No. 2, pp. 1-2.
- Chandroo K. P., Moccia R. D. & McKinley R. S. 2000. Utilization of physiological telemetry to monitor behavioural responses of rainbow trout, *Oncorhynchus mykiss* (Walbaum), to captive culture conditions. Bulletin of the Aquaculture Association of Canada 99(4), 34-36.
- Cooke S. J., Chandroo K. P., Beddow T. A., Moccia R. D. & McKinley R. S. 2000. Swimming activity and energetic expenditure of captive rainbow trout, *Oncorhynchus mykiss* (Walbaum), estimated by electromyogram telemetry. Aquaculture Research 31, 495-505.
- Davis K. B. & Parker N. C. 1986. Plasma corticosteroid stress response of fourteen species of warmwater fish to transportation. Transactions of the American Fisheries Society 115, 495-499.
- Davis L. E. & Schreck C. B. 1997. The energetic response to handling stress in juvenile coho salmon. Transactions of the American Fisheries Society 126, 248-258.

- Erikson U., Sigholt T. & Seland A. 1997. Handling stress and water quality during live transportation and slaughter of Atlantic salmon (*Salmo salar*). Aquaculture 149, 243-252.
- Furevik D. M., Bjordal Å., Huse I. & Ferno A. 1993. Surface activity of Atlantic salmon (*Salmo salar* L.) in net pens. Aquaculture 110, 119-128.
- Flight, W. and F. Verheijen. 1993. The 'neck-cut' (spinal transection): Not a humane way to slaughter eel (*Anguilla anguilla*). Aquacult. Fish Manage. 24: 523-528.
- Garcia L. M. B., Hilomen-Garcia G. V. & Emata A. C. 2000. Survival of captive milkfish *Chanos chanos* Forsskal broodstock subjected to handling and transport. Aquaculture Research 31, 575-583.
- Greaves K. & Tuene S. 2001. The form and context of aggressive behaviour in farmed Atlantic halibut (*Hippoglossus hippoglossus* L.). Aquaculture 193, 139-147.
- Grizzle J. M., Chen J., Williams J. C. & Spano J. S. 1992. Skin injuries and serum enzyme activities of channel catfish (*Ictalurus punctatus*) harvested by fish pumps. Aquaculture 107, 333-346.
- Hossain M. A. R., Beveridge M. C. M. & Haylor G. S. 1998. The effects of density, light and shelter on the growth and survival of African catfish (*Clarias gariepinus* Burchell, 1822) fingerlings. Aquaculture 160, 251-258.
- Iversen M., Finstad B. & Nilssen K. J. 1998. Recovery from loading and transport stress in Atlantic salmon (*Salmo salar* L.) smolts. Aquaculture 168, 387-394.
- Johnson S. L., Solazzi M. F. & Nickelson T. E. 1990. Effects on survival and homing of trucking hatchery yearling coho salmon to release sites. North American Journal of Fisheries Management 10, 427-433.
- Kertz, A.F. 1996. Animal care and use: an issue now and in the future. Journal of Anim. Sci. 74: 257-261.
- Kestin S. C., Wotton S. B. & Gregory N. G. 1991. Effect of slaughter by removal from water on visual evoked activity in the brain and reflex movement of rainbow trout (*Oncorhynchus mykiss*). Veterinary Record 128, 443-446.
- Kindischi, G. and B. Kirkpatrick. 1992. A small electric grid for preventing escapism of fish. J. Appl. Aquacult. 1: 103-109.
- Klontz G. W. 1995. Care of fish in biological research. Journal of Animal Science 73, 3485-3492.
- Korovin V. A., Zybin A. S. & Legomin V. B. 1982. Response of juvenile fishes to stress factors associated with transfers during fish farming. Journal of Ichthyology 22, 98-102.
- Kreiberg, H. 1994. A survey of animal care considerations for fish handling. Humane Innovations and Alternatives 8: 592-595.

- Landless P. J. 1976. Demand-feeding behaviour of rainbow trout. *Aquaculture* 7, 11-25.
- Lochmann S. E., Perschbacher P. W., Merry G. E. & Fijan N. 1998. Aggressive biting among channel catfish in pool studies. *The Progressive Fish-Culturist* 60, 119-126.
- Marliave J. B. 1977. Effects of three artificial lighting regimes on survival of laboratory-reared larvae of the sailfin sculpin. *The Progressive Fish-Culturist* 39, 117-118.
- McHugh J. J. 1978. Effects of light shock and handling shock on striped bass fry. *The Progressive Fish-Culturist* 40, 82.
- Monaghan, P. and D. Wood-Grush. 1990. Managing the behaviour of animals. Chapter 5. Chapman and Hall, London.
- Mork O. I. & Gulbrandsen J. 1994. Vertical activity of four salmonid species in response to changes between darkness and two intensities of light. *Aquaculture* 127, 317-328.
- Morton, A. 1994. Fish farming: The final frontier. *Can-Ag-Fax* 1: 1-3.
- National Research Council. 1991. Education and training in the care and use of laboratory animals: A guide for developing institutional programs. National Academy Press, Washington, D.C. p. 139.
- Nickum, J.G. 1988. Guidelines for use of fishes in field research. *Fisheries* 13: 16-22.
- Olfert, E.D., B.M. Cross and A.A. McWilliam. 1993. Guide to the care and use of experimental animals, Vol. 2. Canadian Council on Animal Care, Ottawa, p. 1-10.
- Olfert, E.D., B.M. Cross and A.A. McWilliam. 1993. Guide to the care and use of experimental animals, Vol. 1. Canadian Council on Animal Care, Ottawa, pp. 51-74 and 115-124.
- Øverli Ø., Olsen R. E., Løvik F. & Ringø E. 1999. Dominance heirarchies in arctic charr, *Salvelinus alpinus* L.: differential cortisol profiles of dominant and subordinate individuals after handling stress. *Aquaculture Research* 30, 259-264.
- Pickering A. D. 1992. Rainbow trout husbandry: management of the stress response. *Aquaculture* 100, 125-139.
- Robb D. H. F., Kestin S. C. & Warriss P. D. 2000. Muscle activity at slaughter: I. Changes in flesh colour and gaping in rainbow trout. *Aquaculture* 182, 261-269.
- Robb D. H. F., Wotton S. B., McKinstry J. L., Sørensen N. K. & Kestin S. C. 2000. Commercial slaughter methods used on Atlantic salmon: determination of the onset of brain failure by electroencephalography. *Veterinary Record* 147, 298-303.
- Ross R. M. & Watten B. J. 1998. Importance of rearing-unit and stocking density to the behavior, growth and metabolism of lake trout (*Salvelinus namaycush*). *Aquacultural Engineering* 19, 41-56.
- Sakakura Y., Koshio S., Iida Y., Tsukamoto K., Kida T. & Blom J. 1998. Dietary vitamin C improves the quality of yellotail (*Seriola quinqueradiata*) seedlings. *Aquaculture* 161, 427-436.

- Schreck C. B., Solazzi M. F., Johnson S. L. & Nickelson T. E. 1989. Transportation stress affects performance of coho salmon, *Oncorhynchus kisutch*. Aquaculture 82, 15-20.
- Simmons L., Moccia R. D., Bureau D. P., Sivak J. G. & Herbert K. 1999. Dietary methionine requirement of juvenile Arctic charr *Salvelinus alpinus* (L.). Aquaculture Nutrition 5,
- Skjervold P. O., Fjaera S. O., Østby P. B. & Einen O. 2001. Live-chilling and crowding stress before slaughter of Atlantic salmon (*Salmo salar*). Aquaculture 192, 265-280.
- Specker J. L. & Schreck C. B. 1980. Stress responses to transportation and fitness for marine survival in coho salmon (*Oncorhynchus kisutch*) smolts. Canadian Journal of Fisheries and Aquatic Sciences 37, 765-769.
- Srivastava R. K., Brown J. A. & Allen J. 1991. The influence of wave frequency and wave height on the behaviour of rainbow trout (*Oncorhynchus mykiss*) in cages. Aquaculture 97, 143-153.
- Sutterlin A. M. & Stevens E. D. 1992. Thermal behaviour of rainbow trout and Arctic char in cages moored in stratified water. Aquaculture 102, 65-75.
- Talbot C., Corneillie S. & Korsøen Ø. 1999. Pattern of feed intake in four species of fish under commercial farming conditions: implications for feeding management. Aquaculture Research 30, 509-518.
- Wedemeyer G. A. 1992. Transporting and handling smolts. World Aquaculture 23, 47-50.
- Wedemeyer G. A. 1997. Effects of rearing conditions on the health and physiological quality of fish in intensive culture. In: *Fish Stress and Health in Aquaculture* (ed. by G.K. Iwama, A.D. Pickering, J.P. Sumpter & C.B. Schreck), pp. 35-71. Society for Experimental Biology; seminar series 62. Cambridge University Press, Cambridge.
- Wilson, J.L. and L.L. Roys. 1993. Behavioral interactions in juvenile channel catfish, *Ictalurus punctatus*. J. Appl. Aquacult. 3: 363-381.
- Winfree R. A., Kindschi G. A. & Shaw H. T. 1998. Elevated water temperature, crowding, and food deprivation accelerate fin erosion in juvenile steelhead. The Progressive Fish-Culturist 60, 192-199.

Animal Agriculture and Domestication

Bender, B. 1975. From Hunter-Gatherer to Food Producer. John Baker, London, p. 41-42.

Boghen, A. 1995. Cold - water aquaculture in Atlantic Canada. The Canadian Institute for Research on Regional Development.

Budiansky, S. 1994. A special relationship: The coevolution of human beings and domesticated animals. JAVMA 204: 365-368.

- Budiansky, S. 1992. The covenant of the wild. In: Why Animals Chose Domestication. First Edition, William Morrow and Co., New York, p. 190.
- Clutton-Brock, J. 1981. Domestication as a biological process. In: Domesticated Animals from Early Times. University of Texas Press and British Museum of Natural History. p. 21-25.
- Cole, D.J.A. and G.C. Brander (Eds.). 1986. Ecosystems of the world (21), Bioindustrial Ecosystems. Elsevier, Amsterdam.
- Goudie, A. 1990. The human impact on the natural environment. MTI Press, Cambridge, Massachusetts, p. 338.
- Hemmer, H. 1990. Domestication: The decline of environmental appreciation. Cambridge University Press, Cambridge.
- Henderson, W.H. 1981. Man's Use of Animals. University of Wales Press, Cardiff.
- Kyle, R. 1987. A feast from the wild. KUDU Publishing, Oxford, England.
- Livingston, J.A. 1994. Rogue Primate: An exploration of human domestication. Key Port Books Ltd., Toronto, Ont.
- Peel, L. and D.E. Tribe (Eds.). 1983. Domestication, conservation and use of animal resources. World Animal Science Series, Elsevier, Amsterdam.
- Reed, C.A. 1984. The beginnings of animal domestication. In: Evolution of Domesticated Animals, I.L. Mason (Ed.). Longman, London, New York, p. 1-6.
- Robinson, B.W. and R.W. Doyle. 1990. Phenotypic correlations among behaviour and growth variables in Tilapia: implications for domestic selection. Aquaculture 85: 177-186.
- Ruzzante, D.E. 1994. Domestication effects on aggressive and schooling behaviour in fish. Aquaculture 120: 1-24.
- Sandoe, P. and N. Holtug. 1996. Ethical limits to domestication. J. Agric. Environ. Ethics 9(2): 114-122.
- Sedgwick, S.D. 1984. Salmonids. In: Evolution of Domesticated Animals, Mason, I.A. (Ed.), Longman/Condon Group Ltd., New York, p.452.
- Wohlfarth, G.W. 1984. Common Carp. In: Evolution of Domesticated Animals, Mason, I.A. (ed.), Longman/Condon Group Ltd., New York, p. 452.

Yamada, R. 1984. Potential Domesticants: Freshwater Fish. In: Evolution of Domesticated Animals, Mason, I.A. (Ed.), Longman/Condon Group Ltd., New York, p. 452.

Zhong-ge, Z. 1984. Goldfish. In: Evolution of Domesticated Animals, I.L. Mason (Ed.). Longman, London/Condon Group Ltd., New York, p. 381-385.